REMARKS

This paper is presented in response to the non-final official action dated August 4, 2011, and is timely filed with a petition for extension of time.

Claim Amendments

Claims 1, 10, and 32 are amended herein to recite that substrate core consists of soda-lime glass. Support for the amendments is found in the original application at page 4, last paragraph. Claims 10 is also amended herein to correct a typographical error. Claim 41 is amended to delete the phrase "in the order of magnitude," thus now reciting that the diameter of the substrate core is approximately 0.2 mm, support being found in the original application at page 10, first full paragraph. No new matter has been added.

Claims 1-43 are now pending. Claims 1-20 and 41-43 are under examination, and claims 21-40 have been withdrawn. Claims 1 and 10 are independent.

Claim Objections

Claims 10 has been amended consistent with the examiner's suggestion. Claim 41 has been amended to recite that the diameter of the substrate core is approximately 0.2 mm, thus rendering moot the objection. The objections can now be withdrawn.

Claim Rejection – 35 USC 112 ¶2

Claim 41 was rejected on the basis of the phrase "diameter of the substrate core is in the order of magnitude approximately 0.2 mm" being indefinite, and the examiner interpreted the order of magnitude to be tenths of millimeters. To improve clarity, the phrase "the order of magnitude" has been deleted. As for the term

"approximately" with respect to diameter of the substrate core, the examiner's attention is directed to the original application at page 10, first full paragraph. There, the applicants describe that the shape of the substrate can diverge from purely spherical, such that the resultant spheres can also be designated as being grain-shaped. In this context, the diameter of the "spheres" is described as preferably being "approximately 0.2 mm" and it is in this context that the term should be understood. The applicants respectfully submit that in view of the specification, the person of ordinary skill in the art would not find the claim indefinite.

Claim Rejections – 35 USC 103

Claims 1-5 and 7-9 were rejected as obvious in view of the combination of Nakata EP 0940860, Gay US 4,638,111 and Probst US 5,626,688.

The claims have been amended to clarify that the substrate core upon which a back contact layer is coated "consists of" soda-lime glass, thus excluding substrate materials having an intermediary diffusion barrier / adhesion promoting layer. The Office's rejections based on combinations of the prior art which include such an intermediary diffusion barrier or adhesion promoting layer are thus obviated. The argument herein focuses on the remaining rejections based on a combination of the art which allegedly motivates the presently claimed invention.

The Office alleges that it would have been obvious at the time of the invention to use soda-lime glass disclosed in Probst in making a spherical solar cell according to Nakata by applying a molybdenum back contact layer directly to the substrate in view of Gay "because Probst teaches that soda lime glass is known to have a positive influence" on solar cells.

It is respectfully submitted that the Office is disregarding the complete teachings of the prior art, including Probst, when relying on an isolated statement in Probst for a "positive influence" of soda-lime glass on cell properties.

When viewed as a whole, Probst does not teach an advantage from use of conventional soda-lime glass as a solar cell substrate, but to the contrary criticizes and discourages its use. While Probst teaches that alkali concentration in the absorber layer can have a positive influence, the positive effects are dependent on

"contaminants," col. 1, lines 46-47, and only occur after a specific threshold of alkali concentration is reached, col. 2, lines 32-36, such that the influence of the substrate on the final properties of the cell in the absence of Probst's invention is "**uncontrollable**," col. 2, lines 16-18.

Specifically, the applicants traverse the Office's conclusion, on page 12, lines 20, that "controlling the alkali diffusion by previous methods (substrate treatment)" is achievable based on Probst and that Probst provides a "reasonable expectation of similar results" (*Id.*), because Probst explicitly states the opposite, specifically that the influence of the substrate is "uncontrollable," col. 2, lines 16-18.

Probst teaches that a multitude of factors affect the quality of the resulting cell when using a soda-lime glass substrate without a diffusion barrier layer. As mentioned above, the influence of the effect is initially dependent on contaminants deriving from the substrate. Col. 1, lines 46-47. Examples of other factors described by Probst include cleaning of the surface, duration of storage, storage temperature, moisture level during storage, and other unspecified "pre-treatment" steps or conditions. See col.1, lines 55-63. Probst is completely silent concerning other relevant factors (of which some may not even be known yet).

Probst also teaches that the deposition conditions of the molybdenum back electrode also affect the resulting cell when no diffusion barrier layer is included, because different deposition conditions influence the alkali diffusion behavior . See column 1, lines 63-67.

Probst also teaches that the amount of heat employed during manufacture of the chalcopyrite absorber layer is a further factor when no diffusion barrier layer is employed. See col. 1, line 67, to col. 2, line 3.

Probst also criticizes and discourages use of a soda-lime glass substrate without a diffusion barrier layer and dosed addition of an alkali metal, because of poor adhesion between chalcopyrite layers and molybdenum back electrodes. Col. 2, lines 37-40.

In view of all of the foregoing, Probst states that the influence of the substrate on the final properties of the solar cell, in the absence of a diffusion barrier layer and dosed addition of alkali content according to his invention is "uncontrollable." Column 2, lines 16-18. Thus, Probst does not enable the skilled artisan to practice

the claimed invention with the reasonable expectation of success required by U.S. patent law. See MPEP 2143.02: "Obviousness does not require absolute predictability, however, at least some degree of predictability is required." Probst's teaching that the influence of the substrate on the final properties of the solar cell, in the absence of a diffusion barrier layer and dosed addition of alkali content according to his invention is "uncontrollable" shows that the required degree of predictability is not met by the prior art.

It seems that the Office views the present circumstances as analogous to *In re Fulton*, 391 F.3d 1195, 73 USPQ2d 1141 (Fed. Cir. 2004) cited in MPEP 2143.01. The differences between the facts in *Fulton* and those at hand show that the court's rationale in *Fulton* supports a finding of non-obviousness here. In *Fulton* the applicant argued that a combination of prior art references was improper because (1) the prior art did not suggest the claimed feature (orientation) as the most desirable, and (2) the prior art taught away by showing desirability of an alternative orientation. The Federal Circuit upheld the Board's holding of obviousness, stating that "the prior art's mere disclosure of more than one alternative does not constitute a teaching away from any of these alternatives because such disclosure does not criticize, discredit, or otherwise discourage the solution claimed." MPEP 2143.01, quoting *Fulton* 391 F.3d at 1022-01, 73 USPQ2d at 1145-46.

In stark contrast, Probst does not disclose (a) use of soda-lime glass substrates without diffusion barrier layers, and (a) use of soda-lime glass substrates with diffusion barrier layers and dosed addition of alkali content as "mere alternatives" but rather criticizes and discourages use of the former. As described above, Probst describes a multitude of problems that are associated with the use of impurities from soda-lime glass substrates without diffusion barrier layers, concluding that their use is uncontrollable.

The Office is also required to consider the prior art as a whole, weighing the suggestive power of each reference, when the teachings of prior art conflict. See MPEP 2143.01. To the extent that Probst is viewed as teaching use of soda-lime glass without a diffusion barrier layer, then such teachings conflict with those of the primary reference Nakata.

Like Probst's invention, Nakata also requires use of a diffusion barrier layer, for example a silicon nitride film, to prevent impurities in the core from diffusing and being mixed with semiconductor thin films. See, column 9, lines 20-25:

> formed by low pressure CVD method. The reflective film 2, comprising these two insulating coatings, reflect and disperse incident light. It also prevents impurities contained in core 1 from diffusing and being mixed with the high purity silicon of semiconductor thin film layer which is formed on top of reflective film 2. The minute irregu-

See also column 20, lines 15-16 ("Silicon nitride film 32 prevents the diffusion of impurities from core 31"), column 21, lines 37-38 (silicon nitride film 212), and column 23, lines 17-18 (silicon nitride film 242).

Nakata's teachings are not limited to alkali metal impurities, but rather Nakata requires use of a diffusion barrier layer for impurities categorically. Similarly, Probst does not simply add a dosed amount of alkali metal ions when using a soda-lime glass substrate, but rather still includes a diffusion barrier layer to prevent migration of impurities. Thus, both Nakata and Probst independently teach the use of a diffusion barrier layer for preventing migration of impurities. Probst's teaching regarding the *uncontrollable* potential of alkali metal impurities to improve cell characteristics does not override the explicit teaching of Nakata for a diffusion barrier layer to generally prevent impurities from the core from diffusing out and being mixed with semiconductor materials, and Probst's similar teaching of the advantage of a diffusion barrier layer.

As for the arguments regarding adhesion, it appears that the Office takes the position that Gay teaches that use of an adhesion promoter (Probst's diffusion barrier) is (a) optional and (b) that it would have the expected and predictable result of less adhesion.

First, Gay does not teach that a use of such a barrier with soda-lime glass substrates is optional, because Gay does not address soda-lime substrates at all. Thus, to the extent that the teachings of the Gay and Probst conflict in this regard, the suggestive power of Probst is greater because Probst specifically addresses

soda-lime glass. See col. 2, lines 37-40 of Probst. Thus, Gay does not provide an independent basis for omitting a diffusion barrier layer when using a soda-lime glass substrate.

As for the Office's argument that the invention would be *prima facie* obvious and motivated by a combination of references based on an "expected and predictable result of less adhesion," it is remarkable that the Office would find motivation for a prior art combination based on a *disadvantage* taught by that art. Nevertheless, when the expected result of the claimed invention would be less adhesion, then the invention has achieved an unexpected result because there is no lowered adhesion on the soda-lime glass spheres used as a substrate. The inventors did actually not note any adhesion or chipping problem, when using small soda-lime glass spheres as substrate, despite the high curvature of the substrate.

The applicants also have further evidence of unexpected results, as reflected in the document "CdS Layer Opitimization for CuInS2 Solar Cells Based on Coated Glass Beads" submitted herewith.

It was experimentally shown that using a CIS layer on small soda-lime glass spheres (without a diffusion barrier layer and without the addition of a dosed amount of alkali ions) fill factors of 65% and above may for example be achieved. This is pretty much in line with what can be achieved in Probst using a barrier layer and a dosed amount of alkali ions. In addition, the open circuit voltage may be increased well above the maximum of 500 mV achieved in Probst by using a barrier layer and a dosed amount of alkali ions. A CIS layer on small soda-lime glass spheres (without diffusion barrier layer and without the addition of a dosed amount of alkali ions) may thereby lead to an open circuit voltage of up to 573 mV. In contrast to Probst, this may be achieved reliably without a diffusion barrier layer and without the addition of a dosed amount of alkali ions.

In view of the foregoing, it is clear that principles of U.S. patent law and legal precedent do not permit a finding of *prima facie* obviousness in the present circumstances, and that even if there were *prima facie* obviousness then the *prima facie* case is overcome by unexpected results.

Conclusion

For all the foregoing reasons, claims 1-20 and 41-43 are of proper form and scope for allowance, and such action is solicited.

Should the examiner wish to discuss the foregoing or any matter of form in an effort to advance this application toward allowance, she is urged to telephone the undersigned at the indicated number.

December 5, 2011

Respectfully submitted,

By /Michael Muczynski #48,642/

Michael Muczynski
Registration No. 48,642
MARSHALL, GERSTEIN & BORUN LLP
233 South Wacker Drive
6300 Willis Tower
Chicago, Illinois 60606-6357
(312) 474-6300
Attorney for Applicant